Larval Distribution of *Paraclunio alaskensis* at Point Pinos Sewage Outfall, Monterey County, California

(Diptera: Chironomidae)

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The midge *Paraclunio alaskensis* Coquillett, an intertidal insect, was observed in large numbers in the area of the Point Pinos sewage outfall of Pacific Grove, California. A five week study during the months of July and August 1971 was undertaken because *P. alaskensis* represented an unusually abundant macroscopic organism close to a point source of pollution. The Pacific Grove Primary Sewage Treatment Plant releases into the outfall an average of 1.6 million gallons per day of effluent containing chlorine to lower coliform counts. Chlorine concentrations of 10 ppm are common near the outfall.

The larvae of *P. alaskensis* were chosen for study because they provided a better index of population distribution than the adults which were too mobile and completed their life functions within the time of one low tide (Saunders, 1928).

The larvae in the area of the Pt. Pinos outfall fed on organic detritus or "slime" found in greatest concentrations on the rocks within the first 14 meters from the outfall. The slime consisted of organic sewage, a diatom slick, occasional stunted specimens of the alga *Gigartina papillata* Agardh, and other unidentified components. Each *P. alaskensis* larva spins a silken tube which attaches it to the rocky outcrops where the slime is abundant. During the two daily high tides the tube provides protection from heavy wave action on the vertical rocky surfaces. Saunders (1928) noted that preference is shown for the vertical sides of large boulders and rocks which is also the case at Pt. Pinos. When the larvae leave the tubes to feed during low tides they are able to cling to their rocky habitat by means of prothoracic and abdominal pseudopods.

METHODS.—Data were collected on the distribution of the larvae in the vicinity of the outfall and correlated with distance from the outfall. Thirty-six samples were taken at random at Point Pinos ranging from 0.0 tidal height to approximately 1.5 m above mean low water. Six samples were taken at two control areas within Monterey County: rocky outcrops near Asilomar Beach and Malpaso

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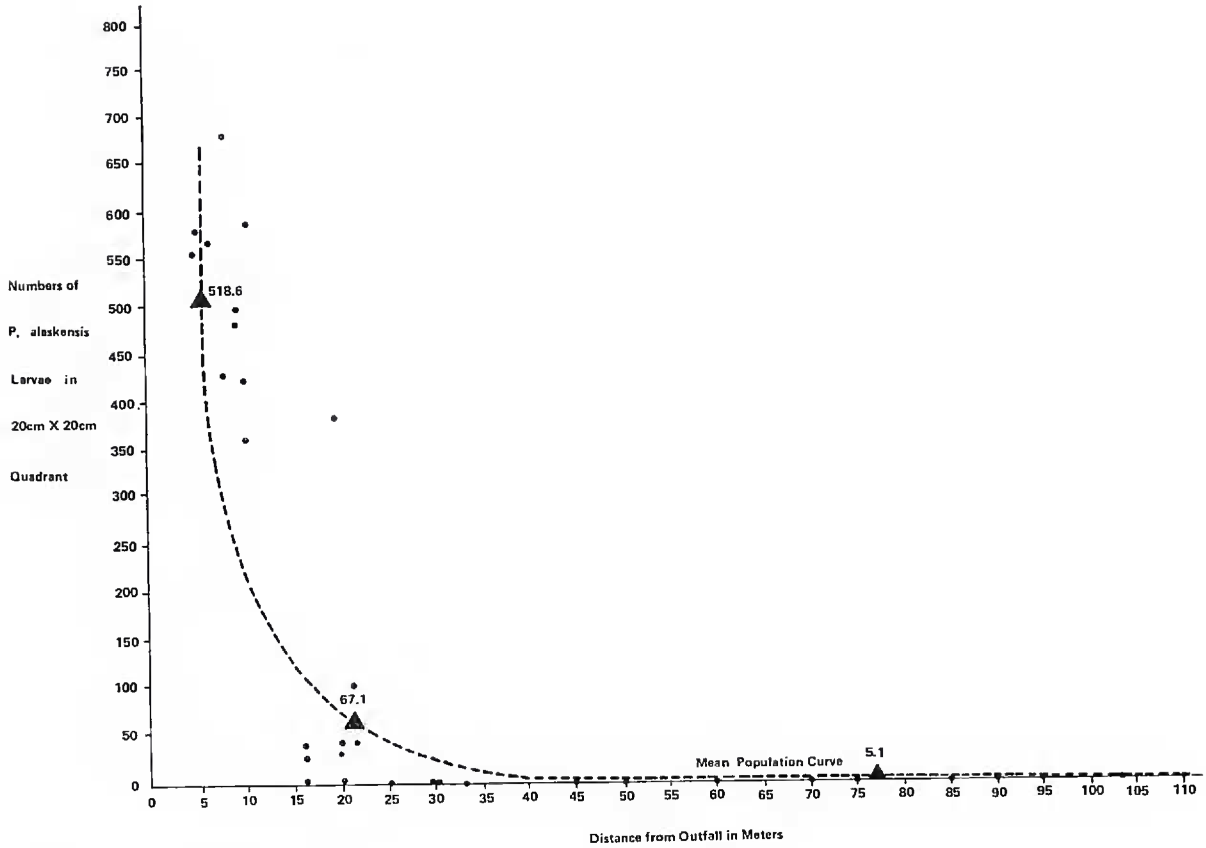

FIG. 1. Distribution of *P. alaskensis* larvae as a function of distance from sewage outfall.

Creek tidepools. Each sample covered a quadrant 20 cm × 20 cm.

The 36 samples taken in the area of the outfall were divided into three groups according to distance from the outfall: 0–14 m, 15–28 m and 29–160 m. Attention was given to the type of substrate and the surrounding vegetation. Ten quadrants were selected from 0–14 m, the area of granitic substrate covered with organic slime. The substrate of the second sample area included eight quadrants with assorted algae, one quadrant from a *Mytilus* bed, and only one quadrant found with organic slime. The quadrants in the third sample area contained slime in one and rocks with a large variety of matted algae and invertebrates in the remaining fifteen. The samples collected in the control areas were from rocks densely covered with macroscopic algae.

Large algae samples were put directly into plastic bags after they were removed. The exposed rock surface was then sprayed with a 50% solution of sodium hypochlorite and all remaining organisms collected.

A collecting tray was constructed to remove larvae from the slime covered vertical rock surfaces surrounding the outfall. This consisted of a sheet metal box measuring 40 cm × 10 cm × 5 cm from which one of the long sides had been removed. Sponges were wrapped in a plastic bag and compressed into the tray. A piece of cheesecloth was then folded and placed over the outer, top edge of the bag covered sponges. This was to provide a surface to which the larvae or any falling particulate matter could cling. The apparatus was firmly held against the lower edge of the 20 × 20 cm quadrants so that the sponges were compressed and took the shape of the rock. The entire quadrant was subsequently scraped and washed with a 50% sodium hypochlorite solution. Both particulate matter and organisms fell onto the cheesecloth. When the quadrant was completely bare the sponges, cheesecloth, and bag were carefully removed from the tray. The plastic bag was turned inside out enveloping the cheesecloth and sample and freeing the sponges. The sample was then taken to the laboratory for counting.

RESULTS.—In the 36 samples taken at Point Pinos (Fig. 1) the mean population for sample group 1 (0–14 m) was 518.6 larvae per quadrant, for sample group 2 (15–28 m) 67.1 larvae, and for sample group 3 (29–160 m) 5.1 larvae. The *t* and Mann Whitney U tests, performed to compare the three groups, passed the 95% confidence limits. There was a significant difference in numbers of larvae as the distance from the outfall increased. No larvae were found beyond 35 m from the outfall. In 22 quadrants containing algae, few larvae were found, except for one sample at 23 m which contained 114 larvae. Very few larvae were in habitats other than organic slime. For example, the sample from the *Mytilus* bed at 25 m from the outfall contained no larvae, whereas at 35 m the sample, the only one of slime in the third area, had 79 larvae. In a quadrant at 9 m, 488 larval tubes were attached to dead *Balanus*; much slime was also present on the rock. No larvae of *P. alaskensis* were found in the samples from the control areas.

At increasing distances from the outfall the number of attached algae and sessile invertebrates increased and *P. alaskensis* larvae decreased. At increasing distances the slime on rocky outcrops, which extended at least 160 m beyond the outfall, also decreased. The larvae seem to thrive when they are not in direct competition with other organisms for substrate, although Saunders (1928) stated that "in spring and early summer on the Pacific Coast of Canada they may be found in almost any matted growth of filamentous algae." Saunders also indicated that sufficient algae were neccessary to harbor larvae. This was not true at Pt. Pinos where larvae subsisted on organic detritus.

The large volume of fresh water effluent may be a significant factor for the abundant *P. alaskensis* larvae and sparse intertidal invertebrates and algae. The effluent is quickly diluted beyond 14 m from the outfall by sea water and this dilution may also lead to declining numbers of *P. alaskensis* larvae. An unpublished study done at Hopkins Marine Station showed that the salinity is approximately 1,000 ppt within the first 14 m beyond the outfall at high tide instead of the normal 3,300–3,500 ppt. Chironomidae are generally found in fresh water and *P. alaskensis* may do best in areas of fresh water flow into the intertidal. Studies will be conducted to sample areas for *P. alaskensis* where fresh water streams containing no sewage empty into the rocky intertidal.

The success of *P. alaskensis* at Pt. Pinos may also be partially attributed to its reproduction by copulation. The female lays her fertile eggs in rocky crevices, whereas most intertidal invertebrates and algae shed their gametes directly into sea water. In an environment polluted with effluence and chlorine, the fertilization of gametes may be adversely affected.

CONCLUSIONS.—*P. alaskensis* larvae are abundant in the area of the sewage outfall at Pt. Pinos where food in the form of organic slime is plentiful on boulders and rocky vertical outcrops. A possible attributing factor for the success of *P. alaskensis* is little or no competition for space from other organisms not physiologically suited to polluted water or to diluted salinity. It is possible that *P. alaskensis* larvae could be used as an index of human sewage pollution in intertidal areas where there is a primary sewage outfall and a rocky substrate.

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